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1 September 2004 – 28 February 2005
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Coastal Observation II – A Continuation of the OASIS Project

Submitted by:

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OVERVIEW

Our mission to develop an integrated coastal ocean observing system for the regions of Virginia, Maryland and Delaware has made significant progress in the September 2004 – February 2005 period and is on track to meet our program goals. Our project continues to mature and expand through technology development and implementation and through the creation of partnerships.

Several significant tasks of the project are nearing the point where they will begin to provide real-time coastal ocean observation data. For instance, two high frequency radar systems (one 3-node long-range and one 2-node standard range) are expected to be operational in June 2005. In addition, we are completing the design and development of a coastal bio-optical buoy system and its ship support infrastructure. Finally, the OASIS effort is nearing the completion of the R&D phase of the platform. This past quarter has witnessed considerable developments in terms of platform fabrication, software development and field testing. We are continuing to develop several novel *in situ* instruments that support ocean color calibration and validation efforts of NOAA and NASA. In addition, we have and continue to participate in various workshops and meetings held to further the development of the U.S. Integrated Ocean Observing System.

I. PROGRAM MANAGEMENT

CIT has been actively engaged in providing program management oversight to the Coastal Observation Project. We have overcome the loss of NASA matching funds to purchase the CODAR HF Radar Systems, and will have these systems operational this summer. The majority of the equipment for this project has been ordered. The Project manager, Mark Yarosh, attended the COTS Workshop hosted by NOAA Charleston in November, and attended the NOAA Grants Administration training in December. Using Grants.Gov we have recently submitted a continuation proposal for the period 1 Sep 2006 – 31 Aug 2009.

The remainder of this report is divided into the following sections: II OASIS Platform; III Sensor Suite development; IV Software Development; V High Frequency (HF) Radar Systems; VI Data Archival Center; VII Regional Partnerships and Outreach; and Project Milestones and Schedule.

II. OASIS Platform

The Ocean-Atmosphere Sensor Integration System platform development effort has passed through a number of milestones. Pacific Gyre, Inc. has completed the design, testing and validation of the robotic control systems for the propeller and rudder. In addition, the platform's central computer system design has been completed. It has been decided that the OASIS platform will carry two microcomputers, one for platform command and control processes and a second for sensor management and data archival and analysis. We are selecting application software to support the sensor systems computer. Emergent Space Technologies has completed the initial design and coding of the software that will operate the command and control processes. The command systems for control of both the rudder and motor were tested on the platform in mid February. Plans are to have a full systems test for radio-telemetered remote control of the platform in mid-March. In mid-May, the integration of the guidance, navigation and control software and Iridium communication modules will be interfaced and field tested. In this interim period, the OASIS platform will have the solar panel system field tested and the mast superstructure will be fabricated and mounted to the hull. The present schedule calls for full field testing of the Guidance and Navigation Control (GNC) software and system communication capability in June. See Appendix A for artist's renderings.

III. Sensor Suite Development

Several sensors are presently under development to support ocean color remote sensing activities.

A. Prototype Phytoplankton Fluorescence Sensing System (PPFSS) Fluorometer: Luna Innovations attempted to make modifications to the PPFSS fluorometer to improve its sensitivity. These modifications include a reconfiguration of the USB2000 spectrometer by the manufacturer, Ocean Optics. They also painted the LED housing/sample chamber black to cut down on reflectance. The sensor was then sent to the EG&G engineering group at Wallops Flight Facility (WFF) for testing. EG&G engineers performed tests of the PPFSS using phytoplankton cultures grown in the biology laboratory at WFF. These tests indicated that the modifications attempted by Luna Innovations did not result in the desired increase in sensitivity observed with the prototype PPFSS built by EG&G. EG&G engineers proposed to change the design of the PPFSS to utilize a fiber optical bundle to deliver the excitation from the individual LEDs directly into the ocean and use the center core of the bundle to deliver the fluorescence directly to the Ocean Optics USB2000 spectrometer. In addition to providing through the hull access to the ocean, the proposed fiber bundle design will eliminate problems of clogging of the 2 mm chamber inlet and bio-fouling on the inside of the sample chamber that was anticipated in the Luna Innovations designed instrument. A schematic diagram of the PPFSS in the new configuration is shown in Figure 1. The hardware needed to implement the new configuration has been specified.

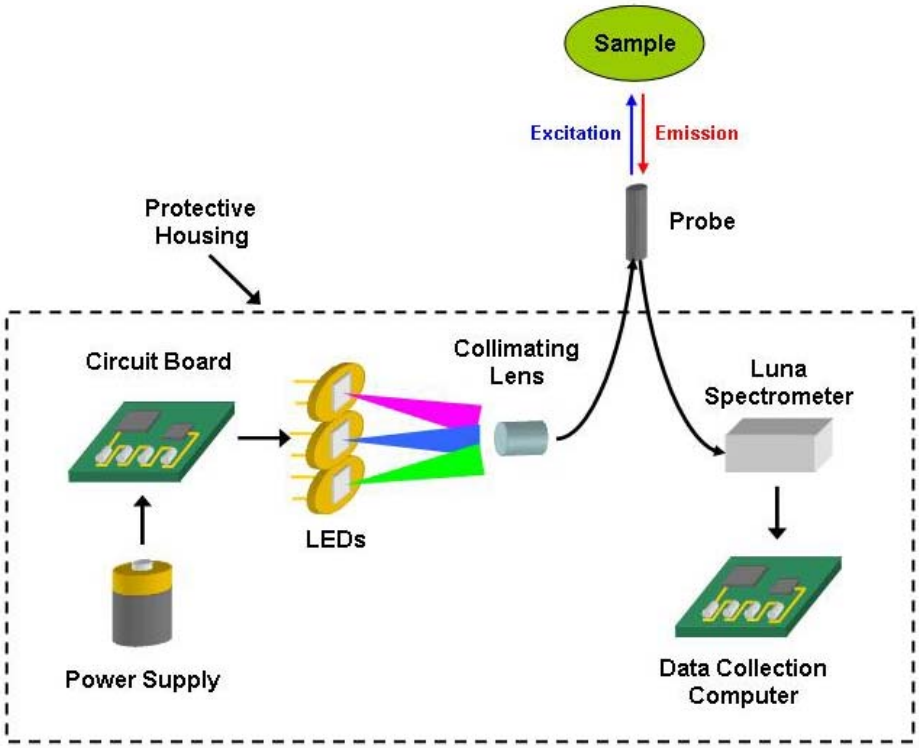

Figure 1. Schematic Illustration of the PPFSS fluorometer with the fiber optical bundle configuration.

B. Above-water Optical Pointer: A second project under development will create a robotic pointing system for a 19-channel above water radiometer system. This system, called BioSAS, is fabricated by Biospherical Instruments and measures remote sensing reflectance—a direct satellite validation measurement for ocean color. The objective in this project is to use this type of instrument aboard small tethered (buoys) or surface autonomous (OASIS) platforms. During this period of activity, we have obtained a design and quote for the purchase of the new BioSAS system and we are developing the robotic control system design. Out intent is to develop a robotic 3 degrees-of-freedom gimbal to mitigate the platform role, pitch and yaw motions. The engineering and robotic control law equations for this system are simple. The task is to develop a solution that can accommodate the range of motions observed by small sized surface platforms (3m discus buoys, OASIS, etc.). The principle application of this control device is for use on the OASIS platforms, but it will be capable of installation on NOAA National Data Buoy Center (NDBC) buoys as well.

IV. Software Development

The OASIS software development continues to move forward. There are a number of ongoing efforts. The OASIS simulator was completed in this past period. We now are able to simulate the GNC software capabilities within a simulated realistic ocean environment. The simulation software uses simulated surface circulation fields from the

Rutgers Regional Ocean Modeling System (ROMS), a state-of-the-art ocean circulation model. With the completion of the simulator, we now have a way to test our objective mapping capability in order to develop the "dynamic mapping" algorithms that we are now focusing on for mapping surface ocean features in an optimized manner. This "dynamic mapping" capability will be used with the Autonomous Sensor Fleet (ASF) software effort that is under development with NASA support. The ASF software will create a mechanism to support management and deployment of fleets of OASIS platforms. The ASF software will utilize the OASIS platforms to support real-time *in situ* testing of the software. These tests will be held when we complete fabrication of additional OASIS platforms.

V. High Frequency (HF) Radar Systems

Two separate HF Radar systems have been ordered from CODAR Ocean Sensors. The first system is a 3-node long-range (200 km) radar system that will tie into the CODAR systems to the north at Cape May (operated by Rutgers University) and to the south at Duck, North Carolina (University of North Carolina). The addition of these 3 nodes will close the gap of HF radar coverage along the northeastern U.S. In addition to these, a 2-node standard-range system was also ordered. These 2 CODAR units will be operated jointly by NOAA/NOS and ODU and tied to the present 2-node standard range system located at the mouth of the Chesapeake Bay. Purchase orders were made by CIT in February and we anticipate receiving the systems in late April.

John Moisan attended a workshop on data quality and assurance held in Norfolk, VA in February and worked with CODAR, NOAA and Rutgers staff to coordinate the installation and maintenance of the systems. During the month of March he will locate the specific sites for the long-range systems. The standard-range sites are being worked out jointly by ODU and NOAA/NOS.

VI. Data Archival Center

We have begun developing the data archival system. Our recent efforts have focused on investigating the solutions developed by other regional observing systems. We have already purchased an initial computer system to handle data storage for the initial field surveys. We have established a relationship with Rutgers scientists to have them process the CODAR data along with the entire northeastern US CODAR data sets to create a regional product. Our data archival system will serve as the applications storage system and will act as the back-up for the Rutgers CODAR archive that will support research efforts. An initial archive plan is presently under development and is being designed to parallel other regional archiving systems.

VII. Regional Partnerships and Outreach

J. Moisan and T. Moisan have attended several of the regional observing system developmental workshops and are working within the regional association which is holding its initial meeting in May. A number of partnerships have been developed and we are continuing to develop others. We are collaborating with Drs. Antonio Mannino and Stan Hooker, both of NASA/GSFC. Dr. Mannino's focus is on the cycling of dissolved organic matter in the coastal ocean and Dr. Hooker works exclusively on ocean bio-optics. They are collaborating closely with Tiffany Moisan by participating on the seasonal field surveys and in assisting in the development of the coastal ocean bio-optical buoy. Dr. Hooker is also working with John Moisan to develop the optical pointing system for the BioSAS system. In the past few months we have initiated collaboration with folks at the NOAA/NOS facility (Mark Bushnell) and Old Dominion University (Larry Atkinson, Jay Austin) to manage the two standard-range HF radar systems and maintain them in an operational mode. Funds from FY2005 will be directed to support this effort. In addition, Tiffany Moisan is collaborating with Drs. Arnoldo Valle-Levinson and Margaret Mulhollland (ODU) to characterize the links between the physics, chemistry and bio-optics. Dr. Valle-Levinson will participate by analyzing the physical oceanography observations acquired during the seasonal field surveys. Dr. Mulholland will also collaborate through participation on the field surveys but will focus more on productivity and nutrient dynamics. In addition, a post-doc (Dr. Jose L. Blanco) has recently been hired at ODU. He will be stationed at NASA/WFF and collaborate with Tiffany Moisan and Arnoldo Valle-Levinson.

We have established a collaboration with Josh Kohut of Rutgers University, to develop a region-wide HF Radar surface current product using all of the long-range seasondes located between Duck, NC and Cape Cod, MA. In addition, we have submitted a proposal to NASA with colleagues from the University of Colorado, the University of Rhode Island, Rutgers University, the University of Connecticut, and the U.S. Coast Guard to utilize the HF radar and satellite-derived surface current estimates to support USCG search and rescue applications. Furthermore, we are presently working with Rutgers to establish a protocol for the archiving of the HF Radar data sets by using NASA/WFF and Rutgers as redundant storage facilities. At this time, John Moisan is investigating and securing potential facility sites for the three long-range radar systems. CODAR Ocean Sensors and Rutgers personnel will collaborate with him in the spring to assemble and deploy the systems.

We continue to work with Dr. Bill Boicourt (UMCES) to develop the coastal bio-optical buoy (COBY). Presently, we are assembling the list of items that are required to be purchased and manufactured to fabricate and equip the buoy. We have determined that a 3m NOAA/NDBC-type buoy will be the most appropriate design for our needs.

During the winter and early spring, Drs. Tiffany and John Moisan met with a number of academic researchers affiliated with the Virginia Marine Science Consortium. This effort resulted in their identifying several new collaborators in the COBY cross-shelf surveys. These individuals include: Dr. William Scott Johnson (Goucher College, MD), who will

participate in zooplankton studies; Drs. Julie Ambler (Millersville University, PA) and Nancy Butler (Kutztown University, PA), who will also work on zooplankton studies; Dr. Yin Soong (Millersville University, PA), who will work on the along-shelf circulation patterns; and Dr. Jessica Nolan (York University, PA), who will collaborate with T. Moisan to study coastal bio-optics and phytoplankton photophysiology.

An air-sea heat, momentum and gas flux effort continues to progress through support of Drs. Jeff Hare and Chris Fairall (NOAA/ETL) and Wade McGillis (Lamont-Doherty). The goal in this effort is to develop a complete air-sea flux system that can be incorporated onto the OASIS platforms. We anticipate that the initial system is ready for testing in the fall of 2005.

T. Moisan continues to collaborate with Pat Tester (NOAA) to develop a capability to use the OASIS platform to identify, track and monitor Harmful Algal Blooms. A late summer-early fall field test of this capability is scheduled for Pamlico Sound, NC.

VIII. Project Milestones and Schedule

Task	**Milestone Date**
HF Radar System Design	May 2, 2005
HF Radar System Delivery and Testing	May 9, 2005
HF Radar System Deployment	May 16, 2005
Development of HF Radar Archival System	April 18, 2005
HF Radar System Operational	May 23, 2005
OASIS Simulator Software Completion	January 14, 2005
OASIS platform sea test	February 15, 2005
OASIS remote radio-control	February 17, 2005
OASIS GNC test	May 23, 2005
OASIS open ocean field tests	May 31, 2005
Begin Additional OASIS platform fabrications	June 1, 2005
OASIS HAB Inst. Field tests	August 29, 2005
Design of COBY	April 15, 2005
Fabrication of COBY	May 15, 2005
Instrumentation of COBY	May 27, 2005
Deployment of COBY	June 15, 2005
Develop COBY line instrument system	May 15, 2005
Bi-weekly COBY lines	Begin June 15, 2005
Complete archival design for COBY and field data sets	June 15, 2005
Carry out seasonal field surveys	Begin March 29, 2005
Deploy ADCPs for CODAR validations	June 15, 2005

Appendix A -Artist's Renderings of OASIS